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sympathy between all classes of productive labor, manual and intellectual, lies our only hope for the future. I can not do better than conclude by quoting the words of Pope, one of our most characteristically British poets:

By mutual confidence and mutual aid
Great deeds are done and great discoveries made.

WHERE DOES ZOOLOGY STAND?

By Professor J. STANLEY GARDINER
PRESIDENT OF THE ZOOLOGICAL SECTION

THE public has the right to consider and pass judgment on all that affects its civilization and advancement, and both of these largely depend on the position and advance of science. I ask its consideration of the science of zoology, whether or not it justifies its existence as such, and, if it does, what are its needs. It is at the parting of the ways. It either has to justify itself as a science or be altogether starved out by the new-found enthusiasm for chemistry and physics, due to the belief in their immediate application to industries.

It is a truism to point out that the recent developments in chemistry and physics depend, in the main, on the researches of men whose names are scarcely known to the public; this is equally true for all sciences. A list of past presidents of the Royal Society conveys nothing to the public compared with a list of captains of industry who, to do them justice, are the first to recognize that they owe their position and wealth to these scientists. These men of science are unknown to the public, not on account of the smallness of their discoveries, but rather on account of their magnitude, which makes them meaningless to the mass.

Great as have been the results in physical sciences applied to industry, the study of animal life can claim discoveries just as great. Their greatest value, however, lies not in the production of wealth, but rather in their broad applicability to human life. Man is an animal and he is subject to the same laws as other animals. He learns by the experience of his forebears, but he learns, also, by the consideration of other animals in relationship to their fellows and to the world at large. The whole idea of evolution, for instance, is of indescribable value; it permeates all life today; and yet Charles Darwin, whose researches did more than any others to establish its facts, is

too often only known to the public as "the man who said we came from monkeys."

Whilst first and foremost I would base my claim for the study of animal life on this consideration, we can not neglect the help it has given to the physical welfare of man's body. It is not out of place to draw attention to the manner in which pure zoological science has worked hand in hand with the science of medicine. Harvey's experimental discovery of the circulation of the blood laid the foundation for that real knowledge of the working of the human body which is at the basis of medicine; our experience of the history of its development gives us good grounds to hope that the work that is now being carried out by numerous researches under the term "experimental" will ultimately elevate the art of diagnosis into an exact science. Harvey's work, too, mostly on developing chicks, was the starting-point for our knowledge of human development and growth. Instances in medicine could be multiplied wherein clinical treatment has only been rendered possible by laborious research into the life histories of certain parasites preying often on man and other animals alternately. In this connection there seems reason at present for the belief that the great problem of medical science, cancer, will reach its solution from the zoological side. A pure zoologist has shown that typical cancer of the stomach of the rat can be produced by a parasitic threadworm (allied to that found in pork, *Trichina*), this having as a carrying host the American cockroach, brought over to the large warehouse of Copenhagen in sacks of sugar. Our attack on such parasites is only made effective by what we know of them in lower forms, which we can deal with at will. Millions of the best of our race owe their lives to the labors of forgotten men of science, who laid the foundations of our knowledge of the generations of insects and flat-worms, the modes of life of lice and ticks, and the physiology of such lowly creatures as *Amœba* and *Paramecium*; parasitic disease—malaria, Bilhaziasis, typhus, trench fever and dysentery—was as deadly a foe to us as was the Hun.

Of immense economic importance in the whole domain of domestic animals and plants was the rediscovery, early in the present century, of the completely forgotten work of Gregor Mendel on cross-breeding, made known to the present generation largely by the labors of a former president of this Association, who, true man of science, claims no credit for himself. We see results already in the few years that have elapsed in special breeds of wheat, in which have been combined with exactitude

the qualities man desires. The results are in the making—and this is true of all things in biology—but can any one doubt that the breeding of animals is becoming an exact science? We have got far, perhaps, but we want to get much further in our understanding of the laws governing human heredity; we have to establish immunity to disease. Without the purely scientific study of chromosomes (the bodies which carry the physical and mental characteristics of parents to children) we could have got nowhere, and to reach our goal we must know more of the various forces which in combination make up what we term life.

In agricultural sciences we are confronted with pests in half a dozen different groups of animals. We have often to discover which of two or more is the damaging form, and the difficulty is greater where the damage is due to association between plant and animal pests. Insects are, perhaps, the worst offenders, and our basal knowledge of them as living organisms—they can do no damage when dead, and perhaps pinned in our showcases—is due to Redi, Schwammerdam, and Réamur in the middle of the seventeenth century. Our present successful honey production is founded on the curiosity of these men in respect to the origin of life and the generations of insects. The fact that most of the dominant insects have a worm (caterpillar or maggot) stage of growth, often of far longer duration than that of the insects, has made systematic descriptive work on the relation of worm and insect of peculiar importance. I hesitate, however, to refer to catalogues in which perhaps a million different forms of adults and young are described. Nowadays we know, to a large degree, with what pests we deal and we are seeking remedies. We fumigate and we spray, spending millions of money, but the next remedy is in the use of free-living enemies or parasites to prey on the insect pests. The close correlation of anatomy with function is of use here in that life histories, whether parasitic, carnivorous, vegetarian, or saprophagous, can be foretold in fly maggots from the structure of the front part of their gut (pharynx); we know whether any maggot is a pest, is harmless, or is beneficial.

I won't disappoint those who expect me to refer more deeply to science in respect to fisheries, but its operations in this field are less known to the public at large. The opening up of our northwestern grounds and banks is due to the scientific curiosity of Wyville Thomson and his *confrères* as to the existence or non-existence of animal life in the deep sea. It was sheer desire for knowledge that attracted a host of inquirers to investigate the life history of river eels. The wonder of a fish

living in our shallowest pools and travelling two or three thousand miles to breed, very likely on the bottom in 2,000 fathoms, and subjected to pressures varying from 14 pounds to 2 tons per square inch, is peculiarly attractive. It shows its results in regular eel farming, the catching and transplantation of the baby eels out of the Severn into suitable waters, which can not, by the efforts of nature alone, be sure of their regular supply. Purely scientific observations on the life histories of flat fish—these were largely stimulated by the scientific curiosity induced by the views of Lamarck and Darwin as to the causes underlying their anatomical development—and on the feeding value and nature of Thisted Bredning and the Dogger Bank, led to the successful experiments on transplantation of young plaice to these grounds and the phenomenal growth results obtained, particularly on the latter. Who can doubt that this "movement of herds" is one of the first results to be applied in the farming of the North Sea as soon as the conservation of our fish supply becomes a question of necessity?

The abundance of mackerel is connected with the movements of Atlantic water into the British Channel and the North Sea, movements depending on complex astronomical, chemical, and physical conditions. They are further related to the food of the mackerel, smaller animal life which dwells only in these Atlantic waters. These depend, as indeed do all animals, on that living matter which possesses chlorophyll for its nutrition and which we call plant. In this case the plants are spores of algae, diatoms, etc., and their abundance as food again depends on the amount of the light of the sun—the ultimate source, it might seem, of all life.

A method of ascertaining the age of fishes was sought purely to correlate age with growth in comparison with the growth of air-living vertebrates. This method was found in the rings of growth in the scales, and now the ascertaining of age-groups in herring shoals enables the Norwegian fisherman to know with certainty what possibilities and probabilities are before them in the forthcoming season. From the work on the blending together of Atlantic with Baltic and North Sea water off the Baltic Bight and of the subsequent movements of this Bank water, as it is termed, into the Swedish fiords can be understood, year by year, the Swedish herring fishery. It is interesting that these fisheries have been further correlated with cycles of sun spots, and also with longer cycles of lunar changes.

The mass of seemingly unproductive scientific inquiries undertaken by the United States Bureau of Fisheries, thirty to

fifty years ago, was the forerunner of their immense fish-hatching operations, whereby billions of fish eggs are stripped year by year and the fresh waters of that country made into an important source for the supply of food. The study of the growth stages of lobsters and crabs has resulted in sane regulations to protect the egg-carrying females, and in some keeping up of the supply in spite of the enormously increased demand. Lastly, the study of free-swimming larval stages in mollusca, stimulated immensely by their similarity to larval stages in worms and starfishes, has given rise to the establishment of a successful pearl-shell farm at Dongonab, in the Red Sea, and of numerous fresh-water mussel fisheries in the southern rivers of the United States, to supply small shirt buttons.

Fishery investigation was not originally directed to a more ambitious end than giving a reasonable answer to a question of the wisdom or unwisdom of compulsorily restricting commercial fishing, but it was soon found that this answer could not be obtained without the aid of pure zoology. The spread of trawling—and particularly the introduction of steam trawling during the last century—gave rise to grave fears that the stock of fish in home waters might be very seriously depleted by the use of new methods. We first required to know the life histories of the various trawled fish, and Sars and others told us that the eggs of the vast majority of the European marine food species were pelagic; in other words, that they floated, and thus could not be destroyed, as had been alleged. Trawl fishing might have to be regulated all the same, for there might be an insufficient number of parents to keep up the stock. It was clearly necessary to know the habits, movements, and distribution of the fishes, for all were not, throughout their life, or at all seasons, found on the grounds it was practicable to fish. A North Sea plaice of 12 in. in length, a quite moderate size, is usually five years old. The fact that of the female plaice captured in the White Sea, a virgin ground, the vast majority are mature, while less than half the plaice put upon our markets from certain parts of the southern North Sea in the years immediately before the war had ever spawned, is not only of great interest, but gives rise to grave fears as to the possibility of unrestricted fishing dangerously depleting the stock itself. There is, however, another group of ideas surrounding the question of getting the maximum amount of plaice-meat from the sea; it may be that the best size for catching is in reality below the smallest spawning size. I here merely emphasize that in the plaice we have an instance of an important food fish, whose

capture it will probably be necessary to regulate, and that in determining how best the stock may be conserved, what sizes should receive partial protection, on what grounds fish congregate and why, and in all the many cognate questions which arise, answers to either can only be given by the aid of zoological science.

But why multiply instances of the applications of zoology as a pure science to human affairs? Great results are asked for on every side of human activities. The zoologist, if he be given a chance to live and to hand on his knowledge and experience to a generation of pupils, can answer many of them. He is increasingly getting done with the collection of anatomical facts, and he is turning more and more to the why and how animals live. We may not know in our generation nor in many generations what life is, but we can know enough to control that life. The consideration of the fact that living matter and water are universally associated opens up high possibilities. The experimental reproduction of animals, without the interposition of the male, is immensely interesting; where it will lead no one can foretell. The association of growth with the acidity and alkalinity of the water is a matter of immediate practical importance, especially to fisheries. The probability of dissolved food material in sea and river water, independent of organized organic life and absorbable over the whole surfaces of animals, is clearly before us. It is possible that that dissolved material may be even now being created in nature without the assistance of organic life? The knowledge of the existence in food of vitamines, making digestible and usable what in food would otherwise be wasted, may well result in economics of food that will for generations prevent the necessity for the artificial restriction of populations. The parallel between these vitamines and something in sea-water may quite soon apply practically to the consideration of all life in the sea. Finally, what we know of the living matter of germ cells puts before us the not impossible hope that we may influence for the better the generations yet to come.

If it is the possibility in the unknown that makes a science, are there not enough possibilities here? Does zoology, with these problems before it, look like a decayed and worked-out science? Is it not worthy to be ranked with any other science, and is it not worthy of the highest support? Is it likely to show good value for the money spent upon it? Should we not demand for it a professorial chair in every university that wishes to be regarded as an educational institution? And has not the occu-

pant of such a chair a task at least equal in difficulty to that of the occupant of any other chair? Surely the zoologist may reasonably claim an equal position and pay to that of the devotee of any other science? The researcher is not a huckster and will not make this claim on his own behalf, but the occupant of this chair may be allowed to do so for him.

THE MAP OF EUROPE AFTER THE WAR

By JOHN McFARLANE, M.A.

PRESIDENT OF THE GEOGRAPHICAL SECTION

WHEN we turn to Austria we are confronted with the great tragedy in the reconstruction of Europe. Of that country it could once be said "Bella gerant alii, tu felix Austria nube," but today, when dynastic bonds have been loosened, the constituent parts of the great but heterogeneous empire which she thus built up have each gone its own way. And for that result Austria herself is to blame. She failed to realize that an empire such as hers could only be permanently retained on a basis of common political and economic interest. Instead of adopting such a policy, however, she exploited rather than developed the subject nationalities, and today their economic, no less than their political independence of her is vital to their existence. Thus it is that the Austrian capital, which occupies a situation unrivalled in Europe, and which before the war numbered over 2,000,000 souls, finds herself with her occupation gone. For the moment Vienna is not necessary either to Austria or to the so-called Succession States, and she will not be necessary to them until she again has definite functions to perform. I do not overlook the fact that Vienna is also an industrial city, and that it, as well as various other towns in Lower Austria, are at present unable to obtain either raw materials for their industries or foodstuffs for their inhabitants. But there are already indications that this state of affairs will shortly be ameliorated by economic treaties with the neighboring States. And what I am particularly concerned with is not the temporary but the permanent effects of the change which has taken place. The entire political re-orientation of Austria is necessary if she is to emerge successfully from her present trials, and such a re-orientation must be brought about with due regard to geographical and ethnical conditions. The two courses which are open to her lead in opposite directions. On